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COMPOSITE RESIN IN THE LAST 10 YEARS - LITERATURE REVIEW. PART 2: MECHANICAL PROPERTIES

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ABSTRACT

Introduction: This is the second of six articles that present a general view about composite resins in the last 10 years. The mechanical properties of composite resins show their behavior on clinical situations such as chewing. Therefore, this review commits to evaluate hardness and elastic modulus of these materials and to relate them to success and longevity of restorations. **Methods:** 60 manuscript were selected for this literature review searched in PubMed platform. This manuscript should contain information of elastic modulus and/or hardness values of commercial resins. **Results:** The resin with the highest values for both properties was Grandio (Voco GmbH). There was considerable variation in elastic modulus values found for the composite resins. The most cited resins were Filtek Supreme XT (3M / ESPE) ranging from 5.76 to 18.54 GPa, and Grandio (Voco GmbH) ranging from 8.4 to 23.5 GPa. **Conclusions:** The elastic modulus and hardness of resins are values related to fracture strength or wear and long term stability of this material. Using materials that have adequate values of both properties promote greater quality of the performed treatment. Thus, dentists must have information about the composition and mechanical properties of the resin used, since the composite resin is a material widely used clinically and this subject is directly related to the longevity, success and quality of the restoration.

KEYWORDS: Composite resin. Mechanical properties. Composites.

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INTRODUCTION

Due to evolution and increase in the clinical applicability of composite materials there was demanded some stability of their properties, in order to guarantee predictability and longevity of restorations.[1] Since macroparticulates composite have been introduced into the field, manufacturers and researchers seek to change this material composition (monomers, filler particles, photoinitiators and pigments) aiming improvement to stable physical and mechanical properties.[2]

Recently, one of the most significant innovations was the nanoparticulate and nanohybrid composites. They are result of nanometric filler particles incorporated into the matrix.[3,4] These nanometric filler provided the increasing of inorganic content. Consequently, it has improved composite properties such as flexural strength, tensile strength and compression.[5, 6] That is because these mechanical properties depend mainly on the materials microstructure and composition.[7, 8]

By understanding how the composition of this material influences on their mechanical properties, it is important discuss and search for more information about different composite resins available in the field. Thus, dentists can preferably define the used material according to their clinical situation.

A way to find out mechanical properties of composite resins is by submitting the material to different nature efforts, such as masticatory one. So it can be determined their ability to transmit or resist forces applied to them.[9]

There are several types of composite mechanical properties that can be studied. Diametral tensile strength is a restorative material ability of withstand tensile stress produced during chewing.[10] During this test material is submitted to loads that tend to shorten or compress it. By this way, fractures occur due to a combination of tensile and shear stresses.[11] Another property that stands out in composite resins study is flexural strength. On tests to determine this property is produced a combination of different forces like traction, compression and shear.[10]

In addition, other properties that can be studied are elastic modulus and hardness. Elastic modulus can be defined as resistance of a body to elastic deformation when a force is applied on it.[12] It is calculated by the elastic deformation region slope of the stress-strain curve.[13] And hardness is defined as a quantitative measure of deformation. It is calculated by the maximum load applied to the material divided for the contact area that it is projected.[14] Therefore, both attributes portray composite deformation in different and important situations.[15]

Clinically, these properties are relevant mainly for referring to the chewing force because bite forces has different vectors that induce distinct tensions, both in teeth and restorations. Consequently, a high flexural strength and diametral tensile strength, in addition to high values of hardness and elastic modulus make anterior and posterior teeth restoration support more effectively occlusal forces.[10]

This literature review is part of a 6 articles series that will approach different clinical, scientific and biomechanical aspects that affect composite resins in the last 10 years. Accordingly, part II proposal is to evaluate hardness and elastic modulus of the composite resins described by different authors and discuss these parameters in relation to clinical success and longevity of restorations.

MATERIALS AND METHODS

Selected articles of this literature review were searched on Pubmed platform and through references of previously selected ones. The publication time must be between of 2008-2018. The search was performed by combining terms: “hardness”, “elastic modulus”, “composite resin” and “mechanical properties”. A total of 60 articles were obtained in initial search, however, these would only be included in research if it informed elastic modulus and / or hardness values of commercial composites. Thus, were selected 25 articles that evaluated elastic modulus and / or hardness of composite resins in different experimental situations.

RESULTS

Table 1 shows hardness and elastic modulus of 92 different composite tested in 25 articles. The Vickers hardness tests, Knoop hardness and 3-point bending were used to obtain these data. By analysis of these results, it was possible to perceive a considerable variation in elastic modulus values that were found for all resins. The most cited resins were Filtek Supreme XT (3M / ESPE) and Grandio (Voco GmbH). Filtek had an elastic modulus variation between 5.76 – 18.54 and Grandio ranging from 8.4 – 23.5.

Figure 1 shows elastic modulus variation graphic in different articles that tested the 8 most cited resins.

Table 1:
Composite Hardness and Elastic Modulus

AUTHOR	YEAR	COMPOSITE RESIN	MANUFACTURER	EXPERIMENTAL METHOD	HARDNESS (DV)	GRADEUR	ELASTIC MODULUS – GPA (SD)
Rodrigues Jr et al.[16]	2007	Supreme Esthet-X Z-250 Charisma Helio Fill	3M/ESPE Dentsply 3M/ESPE Heraeus Kulzer Vigodent	3-point bending	-	-	5.8 (1.5) 6.9 (0.7) 6.4 (1.0) 5.3 (0.7) 4.9 (0.7)
Moraes et al.[17]	2009	Filtek Z250 Filtek Supreme XT TPH Grandio Premise Concept Advanced	3M/ESPE 3M/ESPE Dentsply Voco GmbH Kerr Vigodent	Knoop hardness test	69.6 (6.1) 72.4 (7.4) 54.9 (2.6) 111.7 (13.6) 62.4 (6.2) 44.8 (2.4)	Kg/mm^2	-
Suzuki et al.[18]	2009	Tetric Evo Ceram Venus Diamond Filtek Supreme XT Grandio	Ivoclar Vivadent Heraeus Kulzer 3M/ESPE Voco GmbH	Knoop hardness test	35 (8) 45 (7) 57 (6) 80 (15)	Kg/mm^2	-
Lien et al.[19]	2010	Filtek Silorane Esthet X Filtek Supreme Dyract Extra Beautiful-II Filtek Z250	3M/ESPE Dentsply 3M/ESPE Dentsply Shofu 3M/ESPE	Knoop hardness test	43 (4) 44 (7) 57 (5) 39 (3) 51 (4) 63 (6)	Kg/mm^2	-
Leprince et al.[20]	2010	Tetric Evo Ceram Synergy D6 Admira Grandio Filtek Supreme XT Filtek Silorane	Ivoclar Vivadent Coltene Voco GmbH Voco GmbH 3M/ESPE 3M/ESPE	Vickers hardness test / 3-point bending	50 (3) 59 (3) 48 (3) 113 (6) 79 (6) 68 (7)	Kg/mm^2	6 (5) 5 (6) 5 (4) 9 (2) 6 (7) 6 (3)

Table 1: (continuation):
Composite Hardness and Elastic Modulus

AUTHOR	YEAR	COMPOSITE RESIN	MANUFACTURER	EXPERIMENTAL METHOD	HARDNESS (DV)	GRADEUR	ELASTIC MODULUS – GPA (SD)
Topcu et al.[21]	2010	Filtek Supreme Ceram X Clearfil Majesty Posterior Premise Clearfil AP-X Filtek Z250 Herculite XRV Quixfil	3M/ESPE Ivoclar Vivadent Kuraray Dental Kerr Kuraray Dental 3M/ESPE Kerr Dentsply	Vickers hardness test	66.9 (3.2) 58.3 (1.9) 102.3 (2.3) 55.5 (1.7) 83.2 (2.4) 77.7 (1.7) 66.3 (1.7) 66.4 (1.0)	Kg/mm^2	-
El-Safty et al.[22]	2012	GrandioSo Flow GrandioSo Heavy Flow GrandioSo Venus Diamond Filtek Supreme XTE Spectrum TPH3 X-tra Base Tetric EvoCeram Bulk Fill SureFil SDR Estelite Flow Quick	Voco GmbH Voco GmbH Voco GmbH Heraeus Kulzer 3M/ESPE Dentsply Voco GmbH Ivoclar Vivadent Dentsply Tokuyama Dental	Nanoindentation	1.0 (0.0) 1.8 (0.0) 1.6 (0.1) 1.5 (0.2) 1.3 (0.0) 0.9 (0.0) 0.7 (0.1) 0.7 (0.3) 1.1 (0.2) 0.8 (0.0)	Gpa	15.6 (0.3) 17.5 (0.2) 24.0 (0.4) 22.2 (1.1) 18.5 (0.2) 15.6 (0.2) 14.4 (0.6) 15.5 (0.1) 15.1 (0.8) 14.7 (0.2)
Czasch et al.[23]	2013	Surefil SDR flow Venus bulk fill	Dentsply Heraeus Kulzer	3-point bending	-	-	5.0 (0.4) 3.6 (0.4)
Bauer et al.[24]	2013	IPS Empress Direct	Ivoclar Vivadent	Vickers hardness test / 3-point bending	44.0 (4.0)	N/mm^2	7.1 (0.3)

Czasch et al.[23]	2013	Empress Direct Opal	Ivoclar Vivadent	Vickers hardness test/ 3-point bending	35.6 (2.9)	N/mm²	6.0 (0.4)
		N'Durance	Coltene		73.5 (6.4)		10.7 (0.5)
		Tetric Evo Ceram	Ivoclar Vivadent		70.9 (3.2)		12.4 (0.3)
		Premise	Kerr		73.8 (4.2)		12.5 (0.5)
		CeramX E3	Dentsply		90.9 (5.6)		12.9 (1.5)
		Empress Direct Dentin	Ivoclar Vivadent		73.5 (1.7)		13.1 (0.3)
		Kalore	GC		73.0 (5.2)		13.4 (0.5)
		Empress Direct Enamel	Ivoclar Vivadent		85.6 (3.1)		13.6 (0.3)
		Ceram X D3	Dentsply		88.0 (3.8)		13.9 (0.9)
		Simile	Pentron Clinical		91.9 (2.4)		14.1 (0.2)
		Miris 2	Coltene		90.3 (3.9)		15.0 (0.8)
		Filtek Supreme XTE	3M/ESPE		115.9 (2.7)		15.9 (0.5)
		Filtek Supreme XT Dentin	3M/ESPE		123.0 (2.6)		16.8 (0.2)
		Venus Diamond	Heraeus Kulzer		91.5 (7.1)		17.3 (0.8)
		Grandio	Voco GmbH		161.3 (12.2)		23.5 (1.5)
		Gradia Direct Anterior	GC		46.5 (3.0)		7.5 (0.5)
		Gradia Direct X	GC		46.9 (5.4)		9.2 (0.6)
		Estelite Sigma Quick	Tokuyama Dental		75.5 (4.5)		11.5 (0.4)
		Filtek Silorane	3M/ESPE		70.5 (2.6)		12.5 (0.3)
		EsthetX	Dentsply		81.8 (4.7)		13.7 (0.3)
		Tertric Ceram HB	Ivoclar Vivadent		86.0 (3.3)		15.2 (0.5)
		Tetric Ceram	Ivoclar Vivadent		82.4 (2.3)		15.2 (0.3)
		Tetric	Ivoclar Vivadent		98.0 (4.8)		17.7 (0.5)
		Estelite Posterior	Tokuyama Dental		119.6 (4.9)		21.5 (0.6)
		Revolution Formula 2	Kerr		33.3 (2.8)		5.8 (0.7)
		Tetric EvoFlow	Ivoclar Vivadent		37.4 (1.5)		6.1 (0.5)
		Gradia Direct LoFlo	GC		32.3 (2.9)		6.6 (0.2)
		VENUS Diamond flow	Heraeus Kulzer		37.9 (3.3)		7.1 (0.7)
		Tetric Flow	Ivoclar Vivadent		50.1 (2.4)		8.2 (0.8)
		X-Flow	Dentsply		56.3 (4.9)		9.0 (0.7)
		SureFil® SDR™ flow	Dentsply		36.3 (3.6)		9.2 (1.0)
		Filtek Supreme XT Flow	3M/ESPE		59.1 (3.8)		9.3 (0.3)
		Gradia Direct Flow	GC		49.3 (3.6)		9.7 (0.5)
		Grandio Flow	Voco GmbH		108.3 (7.9)		15.8 (0.7)

Table 1: (continuation):
Composite Hardness and Elastic Modulus

AUTHOR	YEAR	COMPOSITE RESIN	MANUFACTURER	EXPERIMENTAL METHOD	HARDNESS (DV)	GRADEUR	ELASTIC MODULUS – GPA (SD)
Jun et al.[25]	2013	Metafill CX Spectrum TPH Arabesk Top Charisma Revolution2 Dyract flow Denfil flow Filtekflow Heliomolar HB Solitaire2 Filtek P60 Surefil Quixfil Filtek supreme Grandio Admira Magicfil F2000	Sun Medical Dentsply Voco GmbH Heraeus Kulzer Kerr Dentsply Vericom 3M/ESPE Vivadent Heraeus Kulzer 3M/ESPE Dentsply Dentsply 3M/ESPE Voco GmbH Voco GmbH DMG 3M/ESPE	Vickers hardness test	18.6 (1.2) 59.5 (4.9) 35.7 (0.8) 35.7 (2.4) 26.3 (4.6) 46.0 (5.8) 27.3 (5.1) 47.5 (0.4) 24.7 (0.7) 36.4 (1.9) 77.7 (1.2) 56.9 (7.2) 55.7 (5.1) 54.6 (2.9) 73.3 (3.5) 44.5 (1.3) 41.7 (2.2) 54.2 (1.1)	Kg/mm²	-
Jun et al.[25]	2013	Metafill CX Spectrum TPH Arabesk Top Charisma Revolution2 Dyract flow Denfil flow Filtekflow Heliomolar HB Solitaire2 Filtek P60 Surefil Quixfil Filtek supreme Grandio Admira Magicfil F2000	Sun Medical Dentsply Voco GmbH Heraeus Kulzer Kerr Dentsply Vericom 3M/ESPE Vivadent Heraeus Kulzer 3M/ESPE Dentsply Dentsply 3M/ESPE Voco GmbH Voco GmbH DMG 3M/ESPE	Knoop hardness test	23.9 (2.5) 54.4 (4.7) 51.1 (4.4) 45.7 (2.7) 29.8 (1.2) 51.7 (2.2) 31.4 (2.7) 32.4 (1.9) 32.0 (1.2) 42.2 (0.7) 80.8 (2.2) 59.7 (2.7) 64.8 (1.8) 61.6 (1.3) 80.5 (1.1) 46.3 (0.2) 44.7 (1.2) 54.3 (2.8)	Kg/mm²	-

Thomaidis et al.[26]	2013	Filtek Z-250 Filtek Ultimate Admira Majesty Posterior	3M/ESPE 3M/ESPE Voco GmbH Kuraray Dental	3-point bending	-	-	11.7 (1.7) 12.0 (0.5) 8.5 (0.4) 17.3 (0.9)
Cao et al.[27]	2013	Charisma Diamond Z250 P60 Clearfil AP-X Surefil	Heraeus Kulzer 3M/ESPE 3M/ESPE Kuraray Dental Dentsply	Vickers hardness test	54.9 (2.04) 79.3 (1.3) 82.1 (4.1) 87.2 (2.2) 79.4 (2.3)	Kg/mm²	-
Belli et al.[28]	2014	Clearfil Majesty Posterior Grandio SO Filtek Silorane Filtek Supreme XT Tetric EvoCeram Miris II Venus Diamond Kalore Xenius Base EsthetX Clearfil Majesty Esthetic Tetric Ceram	Kuraray Dental Voco GmbH 3M/ESPE 3M/ESPE Ivoclar Vivadent Coltene Heraeus Kulzer GC Stick Tech Dentsply Kuraray Dental Ivoclar Vivadent	3-point bending	-	-	19.9 (1.3) 14.6 (1.7) 10.9 (0.3) 9.0 (0.4) 8.3 (0.2) 8.4 (0.4) 8.7 (1.0) 6.0 (0.4) 12.2 (1.0) 10.1 (0.4) 7.0 (0.3) 8.7 (0.3)
Leprince et al.[29]	2014	Tetric Evo Ceram Bulk Fill Venus Bulk Fill Surefil SDR Flow X-tra fill X-tra base Sonic Fill Filtek Bulk Fill Xenius Coltene Dual-cure Bulk-Fill Grandio Grandio Flow	Ivoclar Vivadent Heraeus Kulzer Dentsply Voco GmbH Voco GmbH Kerr 3M/ESPE GC Coltene Voco GmbH Voco GmbH	Vickers hardness test/ 3-point bending	47.7 (2.3) 21.7 (0.5) 31.3 (0.7) 70.9 (2.1) 47.0 (1.0) 71.8 (1.2) 28.7 (0.3) 52.3 (4.0) 45.1 (2.9) 120.8 (7.2) 66.8 (3.2)	N/mm²	6.1 (0.4) 3.3 (0.7) 4.7 (0.8) 9.4 (0.3) 7.4 (0.6) 8.6 (0.5) 3.7 (0.7) 8.3 (0.3) 5.9 (0.5) 15.3 (0.7) 8.0 (0.4)
Benetti et al.[30]	2014	Charisma Filtek Supreme XTE Grandio	Heraeus Kulzer 3M/ESPE Voco GmbH	3-point bending	-	-	6.8 (0.3) 10.3 (0.3) 16.8 (0.7)
Bicalho et al.[31]	2014	Filtek LS 4 Seasons Filtek Z250 Beautifil II Z100	3M/ESPE Ivoclar Vivadent 3M/ESPE Shofu 3M/ESPE	Knoop hardness test / 3-point bending	51.3 (1.6) 41.8 (1.6) 81.0 (1.1) 70.3 (1.5) 91.1 (5.1)	HB/T	12.6 (1.3) 14.9 (1.4) 18.7 (0.7) 21.3 (1.4) 21.5 (1.3)

Table 1: **(continuation):**
Composite Hardness and Elastic Modulus

AUTHOR	YEAR	COMPOSITE RESIN	MANUFACTURER	EXPERIMENTAL METHOD	HARDNESS (DV)	GRADEUR	ELASTIC MODULUS – GPA (SD)
Park et al.[32]	2014	Grandio Premise Aelite LS Posterior Estelite Sigma Quick Filtek LS Venus Diamond	Voco GmbH Kerr Bisco Tokuyama Dental 3M/ESPE Heraeus Kulzer	3-point bending	-	-	20.1 (0.9) 13.6 (2.6) 23.8 (2.1) 10.7 (1.3) 13.5 (1.3) 16.5 (1.1)
Rosatto et al.[33]	2015	Tetric EvoCeram Bulk Fill Venus bulk fill Filtek bulk fill SDR Esthet X HD Charisma Diamond Filtek Z350XT	Ivoclar Vivadent Heraeus Kulzer 3M/ESPE Dentsply Dentsply Heraeus Kulzer 3M/ESPE	Vickers hardness test / 3-point bending	106.7 (4.2) 117.3 (7.2) 114.4 (9.0) 103.9 (1.7) 61.1 (3.7) 52.8 (1.7) 114.4 (7.1)	N/mm²	14.5 (0.3) 20.3 (9.4) 15.2 (0.6) 14.9 (0.4) 12.7 (3.7) 9.4 (0.3) 14.9 (0.4)
Randolph et al.[34]	2016	Admira Fusion Clearfil Majesty ES Flow Clearfil Majesty Posterior ELS Flow ELS Exp. flow LC Exp. LC Filtek Silorane Filtek Supreme XTE Gaenial Anterior Grandio Slow Grandio Kalore Tetric Evo Ceram Venus Diamond Flow Venus Diamond Venus Pearl	Voco GmbH Kuraray Dental Kuraray Dental Saremco Dental Saremco Dental Voco GmbH Voco GmbH 3M/ESPE 3M/ESPE GC Voco GmbH Voco GmbH GC Ivoclar Vivadent Heraeus Kulzer Heraeus Kulzer Heraeus Kulzer	Vickers hardness test / 3-point bending	62.0 (1.0) 61.7 (1.7) 108.3 (2.3) 48.7 (0.6) 25.7 (0.6) 55.7 (1.2) 64.7 (0.5) 55.7 (1.2) 99.2 (1.3) 37.0 (0.0) 105.3 (1.5) 60.0 (0.0) 46.7 (0.6) 40.7 (1.3) 68.3 (0.6) 23.7 (0.4) 67.5 (0.9)	N/mm²	8.0 (0.4) 6.3 (0.3) 16.3 (0.7) 6.2 (0.4) 3.7 (0.1) 8.7 (0.6) 13.7 (2.0) 9.6 (0.8) 11.1 (0.6) 5.9 (0.4) 16.3 (0.9) 8.4 (0.3) 7.5 (0.3) 7.4 (0.3) 12.0 (0.7) 4.7 (0.2) 9.6 (0.7)
Issa et al.[35]	2016	Tetric EvoCeram Bulk Fill Filtek Bulk Fill Flowable	Ivoclar Vivadent 3M/ESPE	Vickers hardness test / 3-point bending	0.9 (0.1) 0.4 (0.1)	Gpa	16.7 (1.3) 10.2 (1.5)
Sousa-Lima et al.[36]	2017	Tetric Evo Flow Bulk Fill Empress Direct	Ivoclar Vivadent Ivoclar Vivadent	Vickers hardness test / 3-point bending	0.8 (0.2) 0.8 (0.1)	HB/T	11.5 (2.8) 12.5 (2.6)

Alkhudhairy et al.[37]	2017	Tetric N-Ceram Bulk Fill SonicFill Filtek Bulk Fill SDR	Ivoclar Vivadent Kerr 3M/ESPE Dentsply	Vickers hardness test	39.2 (3.5) 58.3 (4.0) 46.4 (6.1) 27.3 (1.9)	N/mm^2	-
Ayad et al.[38]	2017	SonicFill SureFill	Kerr Dentsply	Vickers hardness test	99.0 (1.3) 82.4 (2.4)	N/mm^2	-
Tsujimoto et al.[39]	2018	Beautifil Bulk Restorative Ever X Posterior FiltekOne Bulk Fill Quix Fill Sonic Fill 2 Tetric Evo Ceram Bulk Fill Tetric N Ceram Bulk Fill Beautifil II Clearfil AP-X Clearfil Majesty ES2 Estelite Sigma Quick Filtek Supreme Ultra Restorative Gænial Sculpt Hermonize Universal Composite Z100 Restorative	Shofu GC 3M/ESPE Dentsply Kerr Ivoclar Vivadent Ivoclar Vivadent Shofu Kuraray Dental Kuraray Dental Tokuyama Dental 3M/ESPE GC Kerr 3M/ESPE	3-point bending	-	-	6.6 (0.6) 13.5 (1.2) 11.8 (1.0) 9.8 (0.9) 8.8 (0.8) 12.3 (1.1) 11.5 (0.9) 6.8 (0.6) 12.1 (1.3) 6.4 (0.5) 7.6 (0.6) 8.9 (0.8) 6.3 (0.6) 6.8 (0.7) 14.1 (1.1)

SD - Standard Deviation

DISCUSSION

The study of composite mechanical properties, such as hardness and modulus of elasticity, is important to understand their influence on clinical success of restorations. The composites hardness is connected to their resistance to fracture or wear and long term stability.[40] The tests are based on how much material will withstand a penetration of some instrument on its surface, thereby simulating a teeth restoration until it suffers wear or fracture.[11] Composite hardness, among other circumstances, is influenced by its composition, which includes type of the matrix, quantity and shape of the particles.[41] It is known that there is an important correlation between hardness and inorganic part of composition. It indicates that the higher their quantity the better is hardness.[10]

About the relevance of elastic modulus, it is related to material deformation. Thereby, composites that are placed in a region that will receive masticatory stress and have a low value of this property will be more likely to suffer deformation and to fail.[42] The 3-point bending test is performed to determine its value. This test consists in submit the sample to a compressive stress in its upper middle part and tensile stress on opposite side.[43] By this way, it is possible to evaluate several mechanical properties such as modulus of elasticity, flexural stress, flexural modulus and fracture strength. It happens because they are all related to deformation of the sample.[44]

Hardness and elastic modulus are important mechanical properties for prognosis and longevity of restorations. Thus, this review resulted in a data analysis of the obtained results, which demonstrated a default value pattern of these properties for the same resins.

It is also noticed that Grandio (Voco GmbH) had satisfactory and significant values of hardness and elastic modulus in several articles even with the results variation. However, the restorative material with the lowest Vickers hardness was Revolution Formula 2 (Kerr). Charisma (Heraeus Kulzer) showed the lowest modulus of elasticity value. These results have a direct relationship with the inorganic part of resins composition, subject that is discussed in part 1 of this review.

The discrepancy of the obtained elastic modulus values is observed in Figure 1. There, it is seen the 8 most mention composite values of this property. It can be known that composites that had higher marked variation are Filtek Z250, Venus Diamond and Filtek Supreme XT.

The divergence between these results may be related to storage conditions of samples until the tests are performed which can contribute to the low values of mechanical properties on the studies.[16]

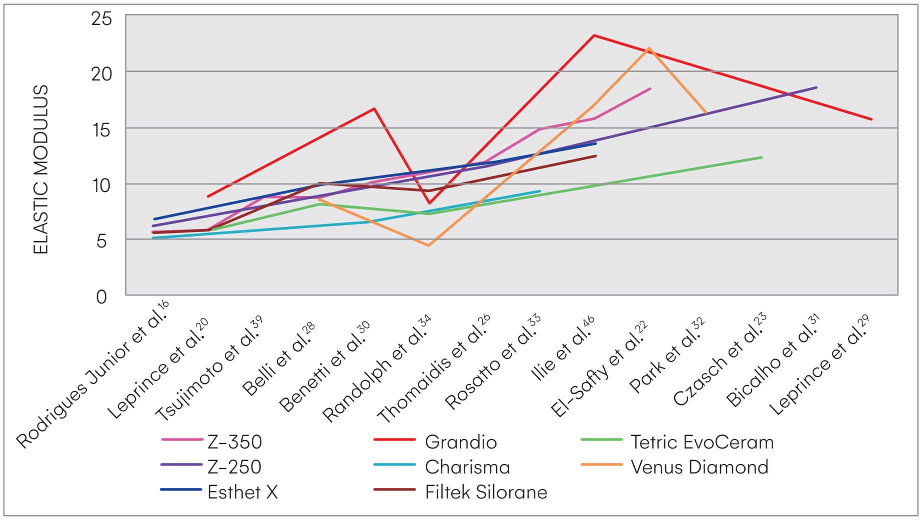

Figure 1:
Variation of composite resins modulus of elasticity according to different authors.

Another issue to be discussed is about this values variation is the samples size which were found several different dimensions of the specimen produced. The sizes that were found ranged from 11×10×2 mm,[27] 2×2×16 mm [46], 2×2× 25 mm,[28] among others. Also, the way these samples were photoactivated directly influence researches results.[47] Some articles followed the manufacturer's recommendations, anothers photoactivated the specimen at 5 different points for 20 seconds.[28] On Part 3 of this review is detail described the influence of photoactivation method on composite resins properties. Another fact that may also affect research results is the amount of samples that were done in each study. A limited number of samples can result in inconsistent data and interfering in the conclusion of this review.

In addition, an important fact is that most of the composite failures restorations are more related to the technique sensitivity performed by the operator than materials properties.[48]

On this literature review, it was not possible to access all the articles that covered this subject, either because they are in other languages than English or due to the lack of access to the file. So, the number of articles researched for the study was restricted, but this limitation did not affect the quality of results.

Therefore, through this literature review, it is possible to perceive how important it is know about the composite modulus of elasticity and hardness. It happens because these values can suffer a great variation depending on the study. As well as there are composite that do not have a satisfactory property value, something that can interfere in the quality of the work done. Understanding and knowing information about composite properties is essential for routine dentist, since these materials are widely used and their mechanical properties are directly related to longevity of restorations.

CONCLUSION

As a result of this literature review, we can conclude that further studies are needed to better understand composite properties. Therefore, it is essential that professionals pay attention not only on composition, but also their influence on the properties of composites and, consequently, on the success of the restorative work. In consequence of that, the dentist will have enough knowledge to choose appropriately the material in each clinical situation and to improve quality and longevity of restorative treatment.

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